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(AN UNDERGRADUATE PUBLICATION)

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AN EXPLANATION OF THE MEDICAL SOCIETY

Now that the elections for the Medical Society have passed and the new executive has been inaugurated, it is in order that a clear understanding of the Society, and its various aspects, be laid before every student in this faculty.

To many, the Medical Society is but a vague organization existing on the campus, completely segregated from the students, and from which few policies ever issue. These ideas are nonsense, born of ignorance, and serving only to weaken the welfare of every medical student enrolled. Your Medical Society, consisting of the officers which you have elected, has given many hours on extensive undertakings, that you might have a well rounded and pleasurable extra-curricular life while at the University of Toronto.

"To deal with all matters pertaining to the general interest and welfare of the medical student," is the sole object of the Society, this objective being directed along scholastic, athletic and social lines.

The members of the Medical Society are elected or appointed by the undergraduate body to hold office for the succeeding year, but in order to understand the Medical Society clearly, it is imperative that a knowledge of its officers and their duties be outlined.

Firstly, the President presides at all meetings of the Society, is ex-officio member of all medical committees, in short he is the co-ordinator of all undertakings pertaining to the advancement of the student body.

The Vice-President assumes the duties of the President in the latter's absence, and is the chairman of the "Meds-at-Home" committee.

The Secretary-Treasurer records the minutes of Society meetings, conducts all outside correspondence, pays all accounts when directed by the President, and in general conducts the financial matters concerned with the Society.

The President of the Medical Athletic Society directs and co-ordinates all matters pertaining to athletics in the faculty, such as purchasing equipment, forming teams and appointing team managers.

The Editor of the Journal is responsible for producing six issues per school year, the articles being contributed by the undergraduates, graduates and members of the teaching staff in the Faculty of Medicine.

The Chairman of Camsi is responsible for the functioning of Camsi in this University, and is Toronto's delegate to Camsi's National Convention held annually.

The Chairman of the Arts and Letters Club is responsible for the regular meetings held by that club. The best speakers from near and far have appeared at these meetings, which have done much to increase the literary knowledge of those attending.

The President of the Women's Undergraduate Association is director of all activities pertaining to the girls in the undergraduate body, including athletic and social activities.

The Presidents from each of the six years in medicine are the representatives of their respective years to the Society.

Outlined, thus, are the pertinent factors of the Society, that is, its aims, its executive, and their duties, with these facts clearly in mind not one undergraduate should plead ignorance as his reason for lack of interest in the Society. This organization is for your benefit in every way, therefore once you have elected officers give them your complete support and continued interest.

Your Medical Society is only as strong as its weakest supporter, don't *you* be that weak supporter!

COMPOUND FRACTURES

E. T. PEER, 4T6

Compound fractures are those sudden solutions of continuity of a bone which communicate with the outside medium, through a break in the skin and soft tissues surrounding the bone.

The communication may be produced in several ways: **FIRST**, by direct violence—i.e. the object which produced the fracture, instead of remaining outside the limb, as it does in simple fractures, has had sufficient force behind it to go through all the overlying tissues, down to the bone, which it breaks. This variety is therefore, a wound from without, and is always infected. **SECOND**, it may be produced by indirect violence—i.e. it is a wound from within, and may or may not be infected, depending on whether or not the wound is contaminated after the accident. This is often the legacy bequeathed on the helpless, and hapless patient by some well-meaning bystander without either the intelligence or the experience to understand that it is quite possible, by sufficient brute-force to shove the sharp end of a broken bone through the overlying skin, thus converting a simple into a compound fracture, and incidentally adding immeasurably to the patient's dangers and distresses. A **THIRD** way of producing the communication, is the professional manner of doing it by the second method, as when a pressure sore develops over the site of the fracture.

The severity of the injury may vary considerably, both as to the wound (which may be clean-cut, or may contain a considerable amount of damaged tissue and foreign material) and the fracture (which may show little or no displacement, or may project through the wound, or may even be comminuted or "pulped").

Certain special compound fractures will be outside the scope of this paper. These include those fractures of the skull which communicate with the sinuses, and those fractures of the jaw which communicate with the mouth.

We shall consider compound fractures under the following headings:

1. Their dangers.
2. The struggle to meet these dangers adequately.
3. The present condition of that struggle.

1. THEIR DANGERS:

The dangers arise, in the main, either from the fracture or from the wound.

The fracture may fail to unite, or there may be vicious union, just as in any other fracture. However, where this has occurred, it will usually be found that the surgeon has failed to appreciate that he is not only treating a wound, but a fracture, and that the principles for the treatment of fractures must apply—i.e. reduction and fixation.

The dangers arising primarily from the wound are **FIRST**, hæmorrhage and shock, if not promptly checked will swiftly carry the patient beyond salvation, and **SECOND**, infection. Here we need to distinguish between primary infection,

introduced by or with the missile, and secondary infection due to contamination from by-standers, doctors, instruments, etc. Primary infection may include, beside the ordinary pyogenic bacteria, the dread anærobic spore-bearers of Tetanus and Gas Gangrene. Secondary infection is due almost solely to pyogenic bacteria, with special emphasis on the hæmolytic streptococci from the noses and throats of those around.

These pyogenic bacteria may invade the soft tissues causing cellulitis, supuration, toxæmia, septicæmia, even pyæmia. They may invade the bone with the production of what has been in the past that prolonged horror—osteomyelitis.

A THIRD danger having its origin in the wound is that of damage to special structures. While this may occur in a simple fracture, the possibility in a compound fracture is infinitely greater.

Finally, even in the process of healing, those structures which managed to evade primary injury, may be incapacitated. Infection may lead to tenosynovitis, or septic arthritis. Adhesions may form greatly reducing the efficiency of the limb.

Wakeley and Hunter sum up the outlook thus: "While compound fractures may be followed by good results if treated early and effectively, delay or defective treatment may involve the patient in the gravest dangers of an infective nature, or may lead to a most wearisome and prolonged convalescence. Life and limb are alike threatened, and even if both are saved, great and crippling disability may follow."

2. THE STRUGGLE TO MEET THESE DANGERS:

Since, from the dawn of time men have found it necessary, for a really happy existence, to go after their neighbours with hammer and tongs—or whatever was more effective—traumatic surgery may justly claim to be oldest and most important province in the domain of the surgeon. One would think, then, that experience would have brought us long ago to something very nearly resembling perfection in this field. Obviously this applies to compound fractures. But, as van Loon so discerningly remarked: "History teaches that history teaches mankind nothing".

Hippocrates insisted that the surgeon must only assist Nature, and not try to bend her to his own will, or confine her to the narrowness of his own theories, we would have found it to our profit, and our patient's advantage, to listen. It was he who insisted, too, on rest as an important therapeutic agent.

The unquestioned authority of Galen sterilized medical thought for generations. Until Theodoric's time, Galen's theory that pus was an essential part of the healing process, held the field. Theodoric lived in the eleventh century. He suggested that pus was not necessary, and advocated dry ("expectant") treatment. The first step in meeting a danger is to recognize it, and Theodoric showed us that pus was of no value, and perhaps of harm.

D'Argellata, a student of Montpellier in the 13th century was the first to use drainage tubes in a wound. Thus the principle of drainage was added to our offensive weapons.

Magati in the early 1600's advocated infrequent changes of dressings as "that method of cure by which wounds are treated most happily and quickly." Desault in the same century began débridement, or wide excision of the wound, and thorough cleaning with removal of all dead and devitalized tissue and foreign bodies.

Larrey followed Desault. He was one of Napoleon's chief medical officers. He pointed out the importance of post-traumatic vascular spasm, as a cause of gas-gangrene—a factor which has only recently been re-discovered. Another of his contributions was his insistence on early treatment. To accomplish this he organized one of the earliest ambulance services.

Pirigoff was a Russian surgeon whom the Russians claim as the originator of the "closed plaster technique". He gained his experience in the Crimean War.

Ollier, in the Franco-Prussian War demonstrated the advantages of immediate immobilization. This was a real advance.

Gamgee was a colourful Englishman. In 1853 he made some very considerable contributions. He pointed out the benefits that would attend fixation and infrequent dressings. He was the first to suggest that pressure on the soft tissues was helpful. His method of accurately describing the optimum amount of pressure (while unintelligible to most of us!) is picturesque. The necessary pressure was about that with which one holds "the hand of a lady when he greets her". It will be noticed how very modern these suggestions appear.

When Lister showed the importance of infection, we should have been well on the way to victory at last. With his beeswax and carbolic acid dressings, he very nearly used the "occlusive treatment" of to-day.

Giana, in 1905 performed some valuable experiments on animals. After inoculating wounds with anthrax, he immobilized some of the limbs, but permitted free movement in others. Where the limb was immobilized, no inflammation or untoward symptoms occurred, but in those cases in which the limb was left at liberty, local infection developed. This was soon followed by general diffusion and death.

About the same time it was shown that while granulation tissue was resistant to bacterial absorption, yet very slight trauma, such as occurs when a dressing is changed, was sufficient to break down this resistance, and permit the entrance of the bacteria.

Winnett Orr states that after reading the works of Paré, Hunter, Larrey, and Lister, etc., he could come to only one conclusion, "that *rest* and the *exclusion of infection* are the two fundamentals so often disregarded but absolutely necessary for the treatment and cure of compound infected fractures". But the end was not yet.

In the war of 1914-18 immobilization and exclusion of infection seem to have been forgotten. Carrel and Dakin in England, introduced the continuous flow of hypochlorite solution. This helped to control infection and dissolved away a good deal of necrotic tissue. However it left pockets of infection untouched, and it was cumbersome, painstaking and messy. Furthermore, adequate immobilization of the limb was impossible. Traction could be used, but it did not sufficiently immobilize

even the soft tissues. Helpful as this method was, it was the last stand of antiseptics. Since that time, the emphasis has been placed on asepsis, and rest. Trueta has expressed the modern feeling on the subject of antiseptics as follows: "No chemical can affect any but the surface organisms. The most effective 'antiseptic' is one that removes dead or dying tissue from a wound; for with these out of the way, the invading organism loses its chief means of gaining a foothold and sustenance." Sir Almoth Wright in 1916 pointed out that antiseptics and frequent changes in dressings were physiologically unsound, since drainage induced simply by hypertonic solutions was more effective in destroying organisms than chemical antiseptics.

Duval, in France, also in the last war, began suturing wounds immediately, after thorough débridement.

Schede and Braun in Germany, during the same period, immobilized the limb in plaster, but they cut a window in the plaster, over the wound. The wound was exposed to the air, without any overlying dressings. Too often, the windows allowed the wound and soft tissues to swell into the gap, where they became very œdematous. The wound wept almost like a varicose ulcer. This condition certainly did not help healing, but the principle had merits.

The stage was now set for some one to combine the lessons of the past. This man was Winnett Orr of the U.S.A. Toward the close of 1918, Orr was shipping his patients back to the United States, with the wounded limb entirely enclosed in plaster. He proved that rest was as important in the healing of a wound of the soft tissues, as it was in the healing of a bone. During the period between the wars he tried valiantly, but vainly to secure a hearing. Up to the present war splinting and frequent dressing, was the approved treatment. One must not criticize the advocates of frequent dressings too severely. We have all passed through the stage in which we dug up our bean seeds to be sure that they were really growing. It was only as we allowed experience to teach us, that we realized such procedure was not helpful to the growth of the plant! To satisfy one's curiosity, one likes to see what is going on, but when the bean plant happens to be the very life of a patient, anything, even "scientific enquiry", which jeopardizes his chances of recovery, is to be condemned, not only as unsound, but as inhuman.

It remained for the Spanish Civil War to give scope for the trial of the new technique. When the tide of opportunity came in, there was someone ready and eager to ride it. He was the Director of Surgery in the General Hospital of Catalonia, and his name was Trueta. His results were astonishing. Two things made Trueta's method a success; his insistence on adequate débridement (which Orr did not stress), and the advent of chemotherapy. But, while he could demonstrate the "how" of his technique, he was unable to show the "why", and surgeons, rightly, are cautious in adopting any new method of treatment, without an adequate rationale. When the Republicans, under whom he had worked, were defeated, he found a shelter in England where he could study the theory behind the treatment. He showed that the value of enclosing the whole limb, wound, fracture, and all, in one occlusive plaster cast, was due to the following factors:

1. Thorough débridement prevented the growth of organisms by removing traumatized tissue, and enclosure of the wound prevented secondary infection.
2. Enforced rest favoured the formation of venous and capillary thromby, thereby preventing the spread of infection.
3. New capillaries forming in the granulation tissue were not torn, in movement.
4. Dehydration and loss of heat were prevented. These were objectionable factors in the method of Schede and Böhler.
5. A beneficial pressure was maintained.

Some have suggested that calcium from the cast may aid in the healing process, since maggots exude calcium carbonate in the destruction of necrotic tissue. Others suggest that the mixture of organisms often found inside such a cast prevents the establishment of a septic process. Obviously these latter are not the prime causes of the benefits derived from this form of treatment. Whether they are of any importance at all, will have to be seen. However, the principles enumerated above, are of very great importance.

3. THE PRESENT CONDITION OF THE STRUGGLE:

During wartime, the ideal treatment of peace must be adapted to the exigencies of war. There will always be some differences, then, between the medicine of war and that of peace.

(a). *Peace-Time Treatment:*

When we first see the patient, our attention must be directed to the whole man. Since the commonest complication of an injury is the presence of another injury, thorough examination is necessary. One should look particularly for any disturbance in the nerve or blood supply of the affected limb, before anæsthesia is begun.

It has already been shown that one of the most immediate dangers, is that of shock. This should be met by giving whole blood or plasma as needed. Morphine, too, by relieving the pain will help considerably. Everything possible should be done to keep the patient quite, confident, and comfortable. It is not too early, at this stage, to begin to look to the future, with all its hazards of infection and the accompanying disability, and obviate them by using chemotherapy, anti-tetanus and anti-gas gangrene sera. In passing, we might emphasize that, while chemotherapy has hastened healing and minimized disability and time loss, it is not, and never will be a substitute for the best surgery.

While the operating room is being prepared, it will be of advantage to have an X-ray plate taken of the injury.

Two questions must be answered before treatment can be commenced: FIRST, "Is an amputation necessary?" The answer is usually, "If in doubt, don't amputate." Treating the compound fracture as will be outlined, and delaying amputation, will not decrease the patient's chances of recovery, and may save a considerable portion of the extremity. Nature's restorative powers should be allowed to operate

unhindered. Their chances of success in producing a functional limb are not improved if a zealous surgeon has already removed it! SECOND: "Are we to use some kind of internal fixation (plates, screws, wire, bone pegs, etc.) or shall we rely on pins passed through the bone, and embedded in the cast?" If one can be sure that infection has been adequately dealt with, internal fixation may be attempted. This will depend on the skill, judgement, and self-confidence of the surgeon. On the other hand, pins may be put through the fragments before the commencement of operation, and by fixation in an apparatus, will maintain the desired position, throughout the procedure, until they are incorporated in the cast, and held solidly therein. They need be no more dangerous than plates, etc., and may be less so. Certainly, pinning has the advantage of speed and simplicity. Winnett Orr points out that one must be sure to use enough pins to be certain that fixation is obtained, and that the pins must be large enough, and fastened sufficiently securely to prevent any "wobble" which will certainly cause a loosening of the pin in the bone, and possibly the introduction of infection.

As soon as everything is in readiness, the patient should be taken to the operating room and anæsthetized. Early treatment is one of the keynotes of modern treatment, and no unnecessary delay should be tolerated. From this point on, less damage will be caused by the bone ends if extension is applied. As already stated, pins will take care of this very well. If they are to be used, now is the time to apply them.

The first step is to prepare the part. The initial dressing is removed, and the wound is packed open with sterile gauze. The surrounding skin is shaved and thoroughly scrubbed. Then the wound itself is washed out with sterile normal saline preferably. Finally the surrounding area is painted with an antiseptic, and the limb is draped.

Now we come to the most important part of modern treatment—débridement. The wound is enlarged longitudinally, so that all parts may be explored and cleaned. The skin margin of the wound is excised, but one need not, and should not remove much more than $1/8$ of an inch, because skin is relatively resistant to infection, and enough should be left to permit one to close the wound without tension. The attention of the operator will be directed deeper and deeper into the wound. All foreign bodies, dead, and dying tissue, etc., must be removed thoroughly. Subcutaneous tissue, muscle, and fascia all require radical treatment. If a tourniquet is around the limb, loosening it periodically will show which tissues bleed, and therefore which tissues have an intact blood supply. If no bleeding occurs, tissue should be removed until it does. This cleaning must extend right to the depths of the wound—through the limb if necessary. During this phase, every effort should be made to preserve all vessels and nerves, with particular emphasis on the arteries. When the surgeon reaches the bone, he will remove the fragments with no periosteal or muscle attachments which would maintain their blood supply, providing they are not too large. Obviously, a good deal of experience and mature judgment is required here, not only to determine when blood

supply is adequate, but also to decide when a fragment is too large to be removed wisely. When débridement is completed, a neat, clean saucerization will have been performed, and perfect hæmostasis will have been secured. The wound should be rinsed out with sterile saline again. It would probably be wise for the surgeon and his assistants to change their gloves, at this stage, before commencing repair.

In most cases, treated as described above, the danger of infection is small, and what little there may be, is quite adequately controlled by chemotherapy, so primary closure may be attempted. While there is still some controversy on the subject, it is probably possible to suture severed nerves at this first, operation. If severe infection is feared, one may put a single suture through the sheath of the proximal and distal portions of the nerve, to aid in its identification subsequently. Sulphonamides or penicillin (in solution) may be used locally in the wound. They should be guided into any remote recesses not completely opened up during débridement. The tissues are closed in layers, but one must be careful, in so doing that excessive tension is not used. If it is necessary to pull a suture until the blood supply is affected, all one's care to remove dead or damaged tissue is made of little effect. In such a case, the suture would be better left out. A dressing is placed over the closed wound.

One may now enclose the whole limb, fracture, wound, dressing and all, in a plaster of paris splint. If pins have been used, these, too, will be incorporated in the cast. Obviously, the site of the wound will determine the extent of the plaster. To put the muscles at rest, and so limit any infection, the joints above and below the site of injury must be immobilized. Winnett Orr found that his patients, with a wound in the lower extremity, were more comfortable if he applied a cast to both the injured and uninjured limbs, and a "cross-bar between. . . . The feet are then held in correct position. . . . This adds to the immobilization of all the injured parts. After the patient is put to bed, a weight and pulley traction on the cross bar between the limbs adds further to his comfort, because it prevents spasm about the thighs, and hips, and helps in the general relaxation of the patient."

b. *War-time Treatment:*

During war-time the number of casualties which may come in at one time precludes the possibility of giving to each, the ideal treatment described above. Emphasis is rightly put on keeping the patient alive, to be repaired later. Thus the combating of shock and infection is the only care of the casualty clearing station.

The dangers of shock and infection will be met as in civilian practice (i.e. by transfusion, serums, chemotherapy, and débridement). However, the wound may be left open, and packed with plain or vaseline gauze, to permit drainage. It has been found that immobilization and extension can best be applied under war conditions when the limb is in a Thomas splint, with Buck's extension. When débridement is complete, plaster of paris is applied over the Thomas splint. This forms what has been termed the "Tobruk Plaster". On the outside of this, relevant details as to the injury and the date on which it was sustained, are recorded for the benefit of those into whose hands the patient will subsequently come. ("Plastogram")

With this arrangement, the patient is easily and comfortably moved to a hospital more remote from enemy action. Here, about five days after the injury, the patient is again anaesthetized, the plaster removed, and the wound closed. At this time, if the fragments are not in good alignment they may be dealt with by internal fixation, or any other method deemed advisable. Nerves may be sutured at this time, as well.

SKIN GRAFTING will be of importance in those wounds which have been packed open, or which have required extensive débridement, so that they may not be closed without too much tension. It is of value not only for the sake of the appearance of the limb, but to avoid a scar which might limit movement, and also to encourage speedy epithelialization as a defence against infection. It has now been fairly well established that skin grafting may safely be begun much earlier than was once thought possible.

No limb which has gone through the ordeals of a compound fracture and its treatment can escape some stiffness, even when surgery has been the best. The patient should be prepared for this, and encouraged to meet it with that determination and enterprise which will restore the limb to useful membership in the body's economy.

Finally, we may say something—or allow those who know to say something—about the results. Col. R. I. Harris of the Canadian Army, and of this University declares: "The cleanly healed wounds, with flexible soft tissues, lack of dense scar, and mobile joints, which result from this plan of treatment, lead to greatly diminished disability." Winnett Orr says: "The convalescence of patients in casts and with infrequent dressings is in marked contrast to that of the ones treated by the more familiar methods requiring dressings which are a source of dread to the patient and of real danger to the wound. The value of the method I have described cannot be demonstrated by laboratory research; nor can statistics showing the much better results obtained suffice to indicate the points of advantage. It is necessary to see the greater comfort of the patients, their freedom from complications, and the great saving in labour and dressings—a purely clinical experience—to understand the many and great advantages of the infrequent-dressing method."

Surely this is an achievement which we may survey with unmitigated gratitude, and sober pride.

(My thanks are due to Dr. Wilson for his criticism of some parts of this paper).

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BIBLIOGRAPHY;

Orr, H. Winnett: "Wounds and Fractures"

Trueta, J.: "Treatment of War Wounds and Fractures"

Harris, Col. R. I.: "War Wounds: The present Status of their Treatment."
C.M.A.J. 52, 5, 450

Rose and Carless: "Manual of Surgery"

VOLKMANN'S ISCHAEMIC CONTRACTURE

W. T. CLARKE M.D., 4T3

Richard Von Volkmann was born in 1830. He became professor of surgery in the University of Halle, Leipzig, and is noted for being one of the first to introduce antiseptic surgery into Germany, for performing one of the first operations for resecting the rectum for cancer, and for founding the *Sammlung Klinischer Vorträge*.

In 1872 he described⁹ a simultaneously developing paralysis and contracture of muscle with an acute onset following injury. The contracture which he described was rapidly progressive and he differentiated it from the later, slowly progressing, and less severe contracture that resulted from nerve injury and which passive movement and splinting would prevent. The contracture which he described could not be prevented by these measures. Nerve lesions were frequently associated with this contracture. At first he believed the pathology to be an inflammatory lesion of the muscle but in a later paper¹⁰ said it was to be understood simply as "death stiffness". He stated that it was caused by stoppage of the arterial blood, often due to too tight bandaging. He had noted signs of marked venous obstruction in the early or developing stage of some cases and believed that in these cases the development of the contracture was even more rapid. Since the original papers by Volkmann, many theories have been advanced to explain the mode of production of the clinical picture which he described.

The most widely accepted theory has been that it is due to venous obstruction causing haemorrhage and exudate into the muscle and a resulting diffuse inflammation and fibrosis. Experimental work carried out by Brooks (St. Louis-1922)² and Middleton (Edinburgh 1930)⁶ provided strong evidence for this. By occlusion of the veins of an isolated muscle in experimental animals they were able to produce an acute muscle paralysis and contracture. This was followed by a diffuse intramuscular fibrosis between individual muscle fibres and a definite fixed contracture occurred. These investigators believed that the pathology of Volkmann's contracture was a similar diffuse acute inflammatory reaction followed by an equally diffuse fibrosis. Brooks realized, however, that occasionally a contracture followed arterial occlusion by ligation or embolism. He stated that this was very rare and that as the pathology was a massive necrosis of the muscle with no diffuse intramuscular reaction it could not be called a Volkmann's contracture. In support of this thesis that the diffuse lesion is the picture in clinical cases of Volkmann's contracture he refers to Leser (1884)⁵ and Power (1907)⁸ who, however, only actually described the microscopical pathology in one case each. The microscopical picture in cases of congenital torticollis described by Middleton⁶ was a diffuse interstitial fibrosis of voluntary muscle but he did not suggest that Volkmann's contracture was caused by a similar mechanism.

Brooks stressed the importance of the varying susceptibility of different tissues in the limb to arterial ischaemia of differing types. He pointed out that in com-

plete and permanent arterial obstruction the skin and subcutaneous structures suffered most, becoming gangrenous. In complete but temporary obstruction however these tissues seemed more resistant, whereas the muscles were mainly affected, becoming necrotic.

Griffiths (Manchester-1940)⁴ was impressed by the contractures that he and others had observed following arterial occlusion. Furthermore in investigating thirty two cases that clinically appeared undoubtedly to be Volkmann's contractures he found that massive necrosis of the muscle was always present. To support his belief in this ætiology he cited records showing absence of the radial pulse in the early stages of some of the cases of Volkmann's contracture. In operations upon these very early cases in which the radial pulse was absent the artery was seen to be in spasm and this could be relieved by removing an injured section of the artery, sometimes, he believed, preventing development of a contracture. Subfascial hæmatomata obstructing the venous return, as postulated by some, was a very rare finding. Arterial spasm is a very real thing clinically and many excellent descriptions of cases in which it has been clearly visualized are presented in his paper.

By tying off the arterial supply to a rabbit's leg, Griffiths was able to produce contractures in a high percentage of cases. Muscle sections taken from these legs showed massive necrosis with only mild inflammation or fibrosis at the periphery of the muscle. This picture was identical with that found in his clinical cases.

EXPERIMENTS

The present work is an investigation of the two conflicting views as to whether the lesion is a hæmorrhagic or true "infarction" due to venous obstruction, or an ischæmic necrosis due to arterial obstruction.

In our first series of experiments a blood pressure cuff was applied to a dog's leg and maintained at a pressure of 120 mms. of mercury, which is between the dog's normal systolic and diastolic pressures for as long as 7 hours. The limb beyond the cuff became swollen, blue, and cold but nothing more than a flaccid paralysis, lasting a day or two and followed by complete recovery, resulted. In an attempt to encourage hæmorrhage into the muscle, as is stated to occur by those who believe in the venous obstruction theory of etiology, the leg was traumatized with a rubber hammer before applying the blood pressure cuff but no contractures resulted.

Clinical cases in which the constricting bandage was on much less than 7 hours with a resulting contracture have been reported. Indeed there are cases in which no bandage was ever applied and no subfascial hæmatoma found to give a venous obstruction, yet a Volkmann's contracture resulted.

Other experimenters have attempted to cause a contracture by tourniquet of various types and have failed to produce it but successful experiments of this type were reported by Barnes and Trueta¹ who used a wire tourniquet surrounded by a rubber tube. By arteriograms they demonstrated marked arterial spasm in both the main artery and its branches lasting many hours after the removal of the tourniquet. Controls did not show this spasm. Contractures developed and muscle

from these animals showed massive ischæmic necrosis similar to that in the cases and experimental work which I am presenting. They suggest that the difference between their experiments and previous ones in which tourniquets were used without contractures being produced, was, that by using a wire, a harder and narrower form of pressure was exerted which was more likely to injure the artery. The wire caused widespread and sustained spasm, whereas ordinary tourniquets only gave local and temporary arterial occlusion.

Having failed to produce contractures by tourniquet pressure in dogs we tied off the common and external iliac arteries of four rabbits repeating the experiments of Griffiths. An immediate flaccid paralysis resulted in three rabbits, one of



Fig. I

Necrotic rabbit muscle. 97 days post-op. Longitudinal section, X300. Note complete absence of nuclei, preservation of outline of cells, and increased prominence of cross striations (Bowman's discs).

which died with gangrene at the site of the incision in forty-eight hours. Sections of the muscle of the paralyzed leg of this animal showed complete disappearance of nuclei but otherwise good outline and structure forty-eight hours after the arterial ligation. In other words a massive necrosis had taken place with only slight cellular reaction at the periphery. The endothelium of the femoral artery was destroyed

and the artery was apparently functionless at this stage. A second animal suffered only transitory weakness of the affected leg. The other 2 rabbits began to develop contractures on about the tenth day which were fully developed by the fifteenth day. Swelling and blueness of the leg were never noted. One rabbit was killed 55 days and the other 97 days after operation. (Fig. I.) In both, affected muscles could be felt as a firm lump before death. When exposed these muscles were yellowish and quite firm in consistency. Sections revealed massive necrosis with fibrous tissue containing some macrophages and giant cells invading from the periphery of the necrotic muscle. The muscle itself was completely devoid of nuclei of any type but otherwise its structure was well preserved; indeed the cross striations were accentuated (Bowmann's disc). (Fig. II.)



Fig. II

Necrotic rabbit muscle 97 days after ligation of arteries. X-section, X60. Note massive necrosis with invasion by fibroblasts and inflammatory cells from the periphery only.

CLINICAL CASES

Six cases of Volkmann's contracture were reviewed. Particular attention was paid to the histopathology of the muscles.

Case No. 1 McCormick Age 10

Supracondylar fracture of humerus, reduced after 3 hours and immobilized with only partial flexion at the elbow. Twenty-four hours after injury she was operated on because of paralysis and anaesthesia in the hand. No sub-fascial haematoma was found and the muscle appeared normal. There was good pulsation in the wound but no radial pulse. The skin was closed under considerable tension showing that tension in the deep structures had been removed by incision of the deep fascia. There was no radial pulse for two days. Good recovery gradually occurred. Biopsy (taken at operation 24 hours after injury) showed diffuse haemorrhage, diffuse acute inflammatory reaction and some necrosis of isolated fibres or small patches of muscle.

Case No. 2 Montero

1934—Fell from horse, compound fracture of fore-arm. 1937—Operated on for non-union. Within eight hours of operation a Volkmann's contracture had occurred. Sections taken at operation 3 weeks later showed large areas of complete necrosis of muscle. The nuclei of the muscle fibres had completely degenerated and only the outline of the muscle cellular structure was preserved. Inflammatory reaction was limited to the periphery of these areas of dead muscle.

Case No. 3 Grenier—Age 23

Fracture of both bones of forearm, cast applied 8 hours after injury and split at once. Hand became numb and paralyzed and a Volkmann's contracture occurred. Biopsies taken at operation 10 weeks after fracture showed some fairly good muscle but other large areas in which there was massive necrosis.

Case No. 4 Glasier—Age 40

Fracture of both bones of forearm. Circular cast applied for 5 days. Glove anaesthesia with only 3 inches recovery of sensation in 10 months. Amputated at level of non-union 10 mos. after injury. Numerous sections from the amputated forearm showed massive necrosis with no evidence of inflammation or fibrosis of the dead muscle tissue except at its edge. Fig. III.

Case No. 5 Giraldi—Age 40

Fractured humerus and both bones of forearm. Plaster cast applied, removed after a few days because hand was dark. 10 days after injury the limb below and including the elbow was paralyzed, anaesthetic and dark coloured. Four months after injury the thumb and index finger were amputated because of gangrene, and 1 year after injury amputation just above the elbow was performed. In the gross the muscles of the forearm were yellowish and of a firm gritty consistency. The nerves were shrunken and fibrous. Numerous sections of muscle again showed massive necrosis.

Case No. 6 Saunders—Age 15

Fracture of both bones of forearm circular cast applied, a severe Volkmann's

contracture occurred. A sinus in the palm of the hand drained for over a year. The hand was amputated two years after injury. Sections showed dense intraneural fibrosis of the median nerve, and periarterial fibrosis of the radial artery. No muscle tissue was examined in this case.



Case No. 4. 10 months after onset of contracture. Longitudinal section, X300. Note complete absence of nuclei, preservation of the outline of the cells, and increased prominence of the cross striations.

DISCUSSION.—

Case No. 1 showed diffuse interstitial hæmorrhage and acute inflammation as described by Brooks. Unfortunately only one small biopsy was taken and this may have been from the edge of a large area of infarction where a similar picture has been found in our experimentally produced contractures.

In case No. 6 only sections from the area complicated by chronic infection could be obtained.

The remaining four cases all showed areas of massive necrosis with only pale outlines of muscle structure remaining, even after many months. There was no interstitial reaction within the muscle bundles and any inflammation or fibrosis present occurred at the periphery of the bundles. It is very difficult to see how

such a pathological picture could have been created by venous obstruction giving diffuse interstitial haemorrhage, inflammation, and then fibrosis. The resemblance of the human cases to the contractures produced experimentally by arterial ischemia was marked.

Examination of the vessels in both the experiments and the human cases revealed that the main arteries were patent and functioning in all except one in which the animal died 8 hours after tying off the artery. In this case it was found that the intima was destroyed and the lumen contained no blood. In the three clinical cases from which sections of arteries were available their walls were somewhat thickened, chiefly the media, and the lumina were reduced in size.

The veins were patent and apparently functioning, there was no evidence of thrombosis.

The nerves in cases No. 4 and No. 5 showed dense fibrosis and disappearance of the neurolemmal sheaths. In case No. 3 and in the experimental animals the nerves did not show any change.

Considerable attention has been drawn to the nerve lesions associated with Volkmann's contractures (3, 7). The evidence suggests that they are ischaemic lesions with a different pathology and prognosis from simple traumatic lesions of nerves. The lesion is essentially an intraneural fibrosis the nerve as a whole being markedly atrophied and fibrosed. This explains the very poor recovery of these lesions.

SUMMARY

1. Volkmann's contracture must be defined and diagnosed on a clinical basis. The essentials are an early onset following trauma of a rapidly progressive paralysis and shortening of muscles of an extremity which can not be prevented or controlled by splinting. Usually there is swelling, blueness and much pain at first. The affected muscles are found to be hard and there is very firm resistance on attempting to overcome the contracture. Frequently there is associated nerve injury.

2. Pathologically such cases usually show a massive necrosis of most of the muscle with very little reaction of fibrosis and such as is present is at the periphery of the necrotic muscle.

3. Clinically the swelling and blueness of the extremity (and persistence of the radial pulse reported in some cases) suggests production of the lesion by venous obstruction and haemorrhage into the muscle. This would produce the diffuse type of reaction described in some cases. In other cases the temporary disappearance of the radial pulse, the absence of any demonstrable cause of venous obstruction, and the demonstration of arteries in spasm apparently due to local injury and capable of being relieved by operation, suggests that the lesion is produced by arterial ischemia. This would give the massive necrosis that is found in the majority of cases. Formation of a thrombus at the site of injury to the artery rather than spasm alone as the cause of arterial obstruction must also be considered as a possibility.

4. There are difficulties in the experimental reproduction of the contracture by either method. Venous obstruction gives a pathological picture similar to the diffuse type of reaction and has only been demonstrated in an isolated muscle. Arterial obstruction gives a pathological picture and end result identical with the cases that show a massive muscle necrosis. Experimental evidence must be applied with reserve. With neither method is the development of the lesion in the experiments identical with its development in clinical cases.

CONCLUSION

1. The mode of production of Volkmann's contracture is one of acute interference with nutrition that may be either arterial or venous in nature. From our work it is believed that it is usually an arterial ischæmia.

2. Prophylaxis is most important but an understanding of the pathogenesis shows that some cases can not be prevented by avoiding tight casts etc. In the early treatment of these cases it is essential to realize the possibility of arterial obstruction as the cause of the contracture.

SELECTED REFERENCES—

¹Barnes and Trueta Br. Jour. of Surg. 30: 74; July '42.

²Brooks Arch. of Surg. 5: 188; '22.

³Holmes, Highet, & Seddon, Br. Jour. of Surg. 32; 259 Oct. '44.

⁴Griffiths D. L. Arch. of Surg. 28: 239; Oct. '40.

⁵Lesser E. Sam'l Klin. Vortr. 3: 2087; '84.

⁶Middleton Br. Jour. of Surg. 18: 188; '30.

⁷Parkes A. R. Br. Jour. of Surg. 32: 43; Jan. '45.

⁸Power. C A. J.A.M.A. 48: 759; Mar. 2, '07.

⁹Volkmann Krankheiten der Bewegungsorgane 1872.

¹⁰Volkmann R. Zentralb f. Chirurgie Dec. 24, '81 reprinted—Jour. Internat. Chir 3: 77; '38.

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ECLAMPSIA

ALICE M. GOODFELLOW 4T6

“By eclampsia is meant an acute toxemia in pregnant, parturient and puerperal women, accompanied by tonic and clonic convulsions and coma in which other diseases may be ruled out. It also includes cases of acute toxemia without convulsions which at autopsy show the changes in the liver known to be characteristic of the acute toxemias associated with convulsions and coma.” (Delee) The state of the patient immediately preceding eclampsia is pre-eclampsia, therefore it is obvious that the latter must be included in any discussion. They are classified as a type of toxæmia occurring in the last trimester of pregnancy. Other similar types are renal and hypertensive disease. Actually, in practice it may be very difficult to differentiate them until the pregnancy has been completed. In this paper, only eclampsia and its precursor will be discussed. In brief, again, they will be thought of as a condition, arising in a previously non-hypertensive or mildly hypertensive pregnant patient, during her last trimester and disappearing before or soon after delivery.

The question is asked, “Essentially, what constitutes this toxemia?” It is a vascular change characterized in its early stages by hypertension, albuminuria and edema. These increase in severity with toxemia. Later, retinal changes and abnormalities of the nervous system are added. If treatment has been inadequate, the ultimate is convulsions and coma, or death or both.

Eclampsia is a major problem in obstetrics. The incidence and mortality rate of mother and fetus are distressingly high. For example, in six state hospitals in Louisiana, in 1943, it was responsible for one-third of maternal deaths.¹⁴ It is felt that such is not necessary if fairly easy and not too time-consuming efforts are exerted. The old saying “Prophylaxis is better than cure,” still applies. Proper prenatal vigilance, and careful interpretation and care of arising symptoms would prevent many a disaster.

It is a common observation that eclampsia has a predilection for primiparas. In a series studied by Arnell, 71% (101 patients) were less than 21 years of age, and 81.2% (116 patients) were primiparas. He also observed that with increasing age and parity, the symptoms were more severe,—the explanation being lowered resistance.¹¹

The etiology of eclampsia is still controversial. Many theories have been proven and disproven. Those worked upon since 1930 will be briefly reviewed.

The internal secretory glands have been investigated. The pituitary gland will be considered first. Anselmino, Hoffman and Kennedy¹⁴ claimed that hyperfunction of the posterior pituitary gland was the cause of water retention and oedema, capillary spasm, rise of blood pressure and toxic albuminuria. In their experiments, on ultra filtrates of the plasma of patients with this toxemia, they demonstrated an excess of antidiuretic and pressor substances. This filtrate also had identical chemical and physical properties as those of the internal secretion

of the posterior pituitary gland. This was not found in normal pregnant patients. Many investigators used the same methods, but failed to confirm their results. Levitt says, "If the blood of patients with eclampsia and related disturbances does contain an increased amount of the hormone from the posterior pituitary our present methods are unable to detect it."¹⁴ Most investigators agree as far as the pressor substance is concerned, but Teel and Reid found an antidiuretic substance in the urine, which they consider "offers an immediate mechanism for the water retention of pre-eclamptic toxemia and eclampsia."¹⁴ Other investigators, including Byrom¹⁴ agree that the lesions of eclampsia and pre-eclamptic toxemia are expressions of vascular spasm. But, he calculated, that the necessary amount of pituitrin would be 250 to 800 units, which level, he does not believe could be reached by natural hormone. But, he feels, it is possible that a pressor substance may be produced elsewhere—placenta—or that the vessels are made hypersensitive by other hormones—oestrogens.

In considering the anterior pituitary-like hormone, Smith and Smith found abnormally high levels in the serum and urine of toxemic and eclampsia patients. This increase was demonstrated 5 or 6 weeks before other signs of toxemia appear. Blood oestrin and urine pregnandiol were found diminished. They considered the imbalance between prolan, oestrin and pregnandiol an important factor in the onset of toxemia. The significance of these findings is that they believe the anterior pituitary-like hormones play a role in the placenta's elaboration of progesterin and oestrin as does prolan in the ovary. In toxemia, there is a failure of the utilization of the hormone by the placenta to produce progesterin and oestrin, with the resulting accumulation. In normal pregnancy, there is noted a decrease of prolan with increase in elaboration of progesterin and oestrogen by the placenta in the third and fourth month. "On this basis one would place the primary etiology of pre-eclampsia in whatever causes the placenta to be deficient in utilization of anterior pituitary-like hormone for production of oestrogen and progesterin." (Smith)¹⁴ Taylor states that perhaps toxic products are formed by utilizing oestrins or by its destruction. Browne and co-workers say that there may not be decreased production of these placental hormones but retention due to failure to unite with glucuronic acid in liver and be excreted by kidney. There is still no unanimous agreement. In the literature, Shute¹⁴ claims that it is necessary to do a blood assay for estrogens in pre-eclamptics and that the administration of such is a helpful measure in the prevention of eclampsia convulsions. He recommends dose of 100,000 I.N.U. of progynon B.

The diet of toxemic patients has received considerable attention. McIlroy¹⁴ writes: "From clinical experience, I am firmly convinced that the way of research and progress lies not so much in a more or less lengthy search for illusive toxins as in the investigation of toxemia as a deficiency disease." But, Browne¹⁴ points out that from 1916 to 1920, in Germany, the incidence of eclampsia fell from .2% to .06. Discrepancies in these figures have been pointed out, yet Bartholomew and Kracke¹⁴ believe that the diets being deficient in cholesterol-containing foods reduced the tendency to formation of placental infarcts, which they consider cause eclampsia.

In experimental series, diets deficient in calcium have shown greater incidence in toxemia. In countries, where Vitamin B deficiency is prevalent, eclampsia has been found more frequent, but daily vitamin B injections have not significantly lowered the incidence.

A low protein diet was first suggested because it was believed, the protein derivatives from the intestines of mother and fetus were too great in amount to be neutralized by antibodies, thus resulting in protein poison. (Tweedy)¹⁴ Then, it was believed that larger protein molecules were absorbed from a more permeable intestinal wall. (Dieckmann)¹⁴ Recently a high protein diet has been advocated. Harding and Van Wyck¹⁴ doubted the harmful effects of high protein. It is obvious that there is an increased demand for good protein in a pregnant woman. If it is not supplied, hypoproteinemia results. Strauss believed oedema and pre-eclampsia followed. Several experiments have been carried out on the diets of pregnant women. One was done in 1941 at the Toronto General Hospital by Ebbs, Tisdall and Scott.¹⁴ So far, there have been no significant results which warrant considering diet the chief or only factor in eclampsia.

The placental toxin theory has been very popular. The placenta is believed to be the source of the toxin causing eclampsia. Eclampsia sometimes occurs in hydatidiform moles, thus pointing to the placenta as cause. The symptoms do not always subside after foetal death, but usually do after the uterus has been emptied. Young¹⁴ established the claim that eclampsia is due to liberation of the products of early autolysis of the placenta. The infarction is due to interference with maternal blood supply. The cause of this was obscure. The products of the necrosed area, liberated, can pass directly into the maternal blood stream. It was pointed out that in accidental hæmorrhage involving only part of the placenta, toxemia is associated, whereas in incomplete separation of the placenta, toxemia is absent. The reason for the infarction, Young concluded was a morbid constitutional influence. There was evidence that vitamin E deficiency caused upset prolan-progesterone balance, interfering with maternal circulation in placenta leading to infarction. Bartholomew claimed that in excessive hypercholesterinæmia in pregnancy, there is storage of cholesterol in arteries of the villi, causing an endarteritis predisposing placental infarction—the direct cause being trauma by the fetus. The crush syndrome has been applied to the placenta. Acid metabolites are absorbed from the damaged tissue, causing renal damage and failure. Page¹⁴, believing that if the placenta is to the fetus as the kidney is to the mother, and ischemia will cause production of a pressor substance—the ischemia occurring whenever the utero-placental circulation is unequal to the demand. But others have shown no evidence of renin in placenta. The hypertension produced by it is not comparable to that of pre-eclampsia.

The fact that increased abdominal pressure may be a factor has been suggested when considering that toxemia occurs when there is great abdominal distension.

Jegoron¹⁴ stated: "There is no toxin; the cause of eclampsia is allergy of the pregnant women whose organism is gradually sensitized against the normal foetus and placenta." This is opposed by the known fact that in allergy a repeated exposure causes the same symptoms. In eclampsia recurrence is only 2 to 3 percent.

Delore¹⁴ suggested that eclampsia might be of microbic origin. The high temperature, mortality and epidemic-like occurrence observed in some districts suggested this. Placental infarcts may be the sites of secondary infection. Others thought that perhaps bacterial toxins acting on sympathetic nervous system caused the convulsion.

Endogenous chemical poisons, due to malfunctioning of kidney and liver have been suggested.

It has commonly been thought that there was a certain type of women more likely to develop hypertension and eclampsia. This predisposing constitution is as follows:- The build tends to be short, thick and stocky. There are abnormalities of hair distribution, facial characteristics and changes suggestive of acromegaly. Pelvis often is of android anthropoid type. Basal metabolic rate is low.

Cerebral dysrhythmia in relation to eclampsia has been investigated in the matter of why some have convulsions and others not. Lennox⁷ found that in a group of patients who had eclamptic convulsions, there had been an abnormal electroencephalogram similar to that of epilepsy. He believed these people to be predisposed to convulsions—the “trigger mechanism” being the toxemia. He also felt that a family or personal history was also another predisposing factor. Additional proof, he pointed out is the fact that anti-convulsive drugs such as a morphine, magnesium sulphate are used to control the convulsions.

The relation between Rh factor and eclampsia was suggested but discarded since it does not explain hydatidiform mole in relation to eclampsia.

Other observers have noted the increased incidence of eclampsia and pre-eclampsia in diabetic and syphilitic patients.

It is generally agreed upon, to date, that the cause of this condition is unknown. Yet, “by exclusion”, the placenta is to be suspected as the “intra-uterine factor”, which is in some way responsible for toxemia of pregnancy. Hill and Trimble³ pointed out that in 640 consecutive cases studied by them, the correlation between the diagnosis of toxemia by placenta alone to the actual history was unsatisfactory.

It is important to recognize eclampsia as early as possible. Thus, frequent observation of the patient, especially in the last trimester is important. What should the doctor look for at this time? There are three important findings which warn of impending disaster if not correct. They are first, edema manifested by sudden excessive weight gain and by obvious swelling of feet, hand and face; secondly, hypertension—detected with a blood pressure apparatus; and thirdly, albuminuria—obvious by simple routine urinalysis.

The cause of edema, in incipient pre-eclampsia is unknown. There are numerous factors related to water retention but none can be blamed as the primary cause. For example, values of venous pressure were found in normal range; osmotic pressure of plasma, although a little lower in toxemia are not consistently or markedly so, as to account for edema; osmotic pressure of interstitial fluids is not unduly increased; capillary permeability was actually found decreased. Sodium retention is recognized with water retention. It has been wondered if steroidal

sex hormones act on the renal tubules, causing increase reabsorption of sodium. Dieckmann and Wagner¹⁴ concluded that hypoproteinemia in pregnancy was a result rather than a cause of abnormal water metabolism. Anemia and vitamin deficiency have been disproved as causes for edema in pregnancy. Endocrine factors have been suggested as the specific factor retaining fluids in cells and tissue spaces. Nevertheless, generalized edema occurs with sufficient frequency to warrant its control.

The cause of hypertension is also unknown. As previously discussed, no pressor substance in the blood or placenta of toxemic patients has been demonstrated in a manner which could be accepted. A systolic pressure mounting over 120 and a diastolic over 90 are regarded with suspicion.

Albuminuria is a result of glomerular damage due to the hypertension.

It is generally agreed upon that the edema appears first, then the rise in blood pressure and appearance of albumin in urine.

The first complaints of the patient are usually fatigue, headache and swelling of the ankles. A more rapid increase in weight is noted. There is decrease in amount of urine excreted. Following these, are a rise in blood pressure and albumin and casts in urine. Some investigators believe there is a spasm of retinal vessels before onset of any symptoms. There may be cardiac symptoms such as dyspnoea and orthopnoea. In more severe cases, there are visual disturbances such as bright spots before the eyes, dim and double vision. In the late stages, there is nausea and vomiting and discomfort in the epigastrium. The mentality is clouded and often there is stupor. If treatment has been absent or inadequate, the eclamptic attack occurs. Those who have not previously had any degree of hypertension rarely have a blood pressure exceeding 200/120 without convulsions. The whole pre-eclamptic stage may have been gradual or fulminating. The attack consists first of a tonic spasm of the whole body lasting a few seconds, then a violent clonic convulsion lasting thirty seconds to two minutes. Coma follows on. In a favourable case, the patient soon wakes up, but if the convulsions are frequent, she may remain in coma. The blood pressure is high and fluctuates from minute to minute. But it may remain normal or relatively low. The earliest sign of impending disaster is a slow fall in blood pressure. The urine boils solid with albumin. There often is oliguria and anuria.

Dexter and Weiss¹⁴ are of the opinion that in the majority of instances peripheral circulatory failure is the most important cause of death. Acute myocardial failure has also to be considered. Cardiac asthma and failure occur in late stages. In one-third of the cases pulmonary edema is found to be the immediate cause of death. "The clinical picture in the advanced stages of the syndrome is, therefore, complex, consisting of a combination of factors referable to water intoxication, hypertensive encephalopathy, cardiac failure, pulmonary edema, cerebral edema, renal insufficiency, uremia, dehydration, acidosis and circulatory collapse, any or all of which may cause death." Psychic disturbance may develop but clear up, as a rule, soon after delivery.

The subsidence of the toxemia is evidenced by loss of edema, fall in blood pressure, decreased albuminuria and disappearance of symptoms. Clinical improvement follows closely on loss of edema. This may occur at the partem, spontaneously or due to treatment. 25% of all cases of eclampsia occur postpartem, but usually within 24 hours of delivery. With diuresis, symptoms usually subside.

Laboratory findings are as follows:- Normal capillary and venous pressure; normal circulation time; slight decrease in capillary permeability; no electrocardiographic changes due to pregnancy; lower basal metabolic rate in pre-eclampsia but considered due to presence of retained water. Studying the blood chemistry, it was noticed that until the toxemia became advanced, the levels of nonprotein nitrogen, blood urea nitrogen, carbon dioxide combining power, chlorides and sodium were same as in normal pregnancy. The plasma proteins are usually lower in toxemia.

<i>Normal..Pregnancy</i>	av.	range	<i>Toxemic Pregnancy</i>	av.	range
Total serum protein	6.7	5.7-7.7		5.6	4.8-6.4
Albumin	4.7			3.5	3 -4
Globulin	2.3			no change	

The uric acid is elevated. There is no change in calcium level.

According to Dexter and Weiss, “ it is concluded that the usual ‘crude’ liver function tests are ordinarily normal during toxemia of pregnancy and abnormal are not closely related to the severity of the process.” There may be a relation between the liver and abnormal water balance, which is not yet known.

Retrograde pyelograms were found of no significance.

Renal function tests such as urea clearance, nitrogen retention were found essentially normal in mild cases and depressed in the more severe. The clearance tests have measured renal blood flow as normal. In the urine, the degree of albumin paralleled severity of the toxemia. Slight increase in red blood cells, white blood cells, epithelial cells and casts were found.

The organs of most interest in pathological study are the brain, the liver, and the kidney. Most studies are on patients dying because of eclampsia. The brains are swollen with flattened convolutions. The brain substance appears pale and edematous. There are local softenings and signs of capillary hæmorrhage especially into the basal ganglia. Microscopic studies show ischemic and regressive changes in cortical ganglion cells. It is wondered if symptoms and signs of pre-eclampsia and eclampsia depend on the cerebral pathology.

The liver lesions are characteristic. There are “large hemorrhagic areas, which may form a red splashed appearance on the surface of the organ. The microscopic picture is a combination of necrosis and hæmorrhage. The necrosis is peripheral in type, being most marked around the portal vein—” (Boyd)¹¹ The necrosis is due to compression by the thrombi formed in the stagnating blood of dilated sinusoids.

The kidneys are swollen, pale and less firm. There is “marked tubular degeneration, with swelling of the epithelium of the convoluted tubules and pronounced

fatty and albuminous changes in the cells. Bell has shown that the essential renal lesion in the cases with eclampsia is a marked narrowing of all the glomerular capillaries, due to great thickening of the capillary basement membrane. As a rule, there is none of the endothelial proliferation. The afferent arterioles may show some of the hyaline intimal thickening which is the hallmark of hypertension.” (Boyd)

“A study of the arterioles in the different organs shows often a slight or moderate thickening of their walls which results either from a hypertrophy of the media or a swelling and hyalinization of the intima or of the entire wall. During life the blood contains an excess of fibrin and coagulates very quickly.” (Delee)

In the lungs, congestion and edema are almost always found. Hemorrhages are common under the pleura.

In the retina, during life, stasis in capillaries and edema of tissues was noted due to spasm and tonic constriction of retinal arteries. Hæmorrhages and cotton wool patches may be noted. A rare complication of severe pre-eclampsia or eclampsia is detachment of the retina. Degenerative changes in cells of retina found at post mortem depend directly on toxic damage to cells.

Dexter and Weiss consider that, “From morphological point of view, toxemia of pregnancy may be looked upon as one condition in which there is selective damage to the endothelial and epithelial cells.

The following is a list of conditions which may be confused with toxemia and therefore, must be considered in the differential diagnosis. Essentially, in most, the treatment would not differ. They are hypertension uninfluenced by pregnancy, edema of pregnancy, acute and subacute glomerulonephritis, chronic glomerulonephritis, pyelonephritis, nephrosis, intercapillary glomerulosclerosis, amyloidosis of the kidney, bilateral cortical necrosis of the kidney; convulsive conditions including epilepsy, hypertensive encephalopathy, cerebral truma, hemorrhage and poisoning; coma including uremia, diabetic coma.

Due to the toxaemia, there is a definite tendency to spontaneous prematurity, stillbirths and neonatal deaths. The fetal mortality in pre-eclampsia without previous hypertension varies between 5% in mild cases to 25% in severe. Those, with previous hypertension, the figures vary between 12% in mild cases and 69% in severe. It has been shown that if the fetus survives the neonatal period, it suffers no ill effects later.

In eclampsia, the maternal mortality approximates 20% although figures vary greatly from clinic to clinic. In follow-up studies on toxemic mothers, permanent postpartum hypertension is found in about one-fourth of those not previously having it. After delivery, there is more tendency to circulatory collapse.¹⁴

“Nowhere in obstetrics is prophylaxis more important or are the results of prevention more striking than in pre-eclampsia and eclampsia.” (Delee) Prophylaxis consists of routine prenatal care with special observation on the blood pressure, the weight and the urine. Dyer believes that measurement of the output of urine in late pregnancy is of great significance due to the fact that he found that a decrease of day urine volume and increase in night volume with an increase in total volume,

and also a decrease in urine volume, day and night, meant impending danger. He found that this change occurred 4 to 6 weeks before signs of toxemia were apparent. He also noted that forcing fluids with 20 ounces of fruit juice, helped to remedy the situation.

At the first sign of impending toxemia, salt and water intake should be restricted, food intake reduced. A milk diet is found of benefit. Daily saline purgative is helpful. Definitely, bed rest is advised.

If the signs of toxemia increase, bed rest is essential. Fluids are restricted and diet, salt free. Elimination is very important. Delee recommends that such patients should have 60 gms. protein, 30 gms. fat, and 400 gms. carbohydrates. Sedative, such as luminal grains 3, three times daily is advised. The blood pressure should be watched carefully.

If signs of toxemia increase in spite of this treatment, patient should be hospitalized in a quiet room. Glucose is administered intravenously—500 to 1,000 c.c. of a 20% solution with large doses of sedative. Delee says that if there are no definite improvements in 24 hours, the pregnancy should be terminated. This may be done by a medical induction if the toxemia is not rapidly advancing in severity. If sure termination is required early, surgical induction by rupturing the membranes, or inserting a bag or bougie. As soon as there is complete dilatation of cervix and the head is engaged, the second stage of labor should be carried out as quickly as possible. In certain cases where the patient is a primipara and the cervix shows no sign of effacement, if the toxemia is rapidly advancing and the case is still clean, a Cæsarean is necessary to save mother and child. Inhalation anæsthesia is detrimental in these cases.

There are differences of opinion regarding the best method of treatment of eclampsia. Stroganoff was the proponent of a conservative method based on the theory that eclampsia is self-limiting and that patient could continue safely to natural labour. Stoeckel is the radical. He performs low cervical Cæsarean sections on all eclamptic patients as soon after their first fit as possible. Most doctors try the middle way,—conservative treatment with emptying of the uterus as soon as it can be safely done. Of 13,000 cases of eclampsia, Arnell reported 11% maternal mortality by the conservative treatment and 23% maternal mortality by the radical treatment.

A brief outline of the treatment of an eclamptic patient is as follows. The physician should keep in mind that perhaps he is not dealing with eclampsia. The patient may not even be pregnant, therefore after examining her, the diagnosis should be certain. On admission, the patient should be put in a dark, quiet room with a nurse in constant attendance. Morphine gr. $\frac{1}{4}$ and sodium thiosulphate gr. $7\frac{1}{2}$ I.V. should be given. The morphine should be repeated every hour until convulsions cease or respirations drop to 10 to 12 per minute. If convulsions are not controlled 20 c.c. of 10% magnesium sulphate may be effective. The patient should be examined, taking note of eyegrounds, blood pressure, heart, lungs, abdominal examination for tone of uterus, and signs of accidental hæmorrhage, condition of the pregnancy, vaginal examination to estimate if patient is in labor or already delivered, and test of catheter specimen of urine. Actually, the patient should be disturbed the least

possible because it is believed that these disturbances initiate convulsions. Arnell says that even rectal examinations may cause a seizure. Cunningham advocates anaesthesia with nitrous oxide and oxygen each time the patient is to be disturbed. If conservative treatment is best, it is carried on as follows. Elimination is prompted by a colonic irrigation, gastric lavage, leaving in one ounce of magnesium sulphate and repeating the magnesium sulphate until the bowels move. If there is marked oliguria, 50 c.c. of a 50% solution of glucose in saline intravenously every 6 hours. A self retaining catheter should be put in to measure the urine output. After the fits have been controlled, the membranes should be ruptured. Bag and bougie are contraindicated as methods of surgical induction due to fact they carry infection and might cause malposition. If there are no contraindications, $\frac{1}{4}$ c.c. of pituitrin may be given. The second stage should be hastened by forceps delivery of the head. When the danger of hæmorrhage has passed, morphine grains $\frac{1}{4}$ can be given and the patient returned to a warm bed. Only water by mouth is given for next 24 hours, then milk for 24 hours, then a soft salt free diet until urine is clear of albumin and the blood pressure is normal. The latter should be watched very carefully is post partem period.

A Cæsarean section is indicated if there is disproportion and if the patient is a primipara, not in labor, especially if she is over 30 years of age.

Postpartem eclamptic seizures are treated medically.

The patient should report to the hospital within the next 6 months for thorough examination. If there is no vascular or kidney damage, future pregnancies are relatively safe.

To date, eclampsia is, as Boyd says, "a disease of theories." If the one and only correct theory could be found, perhaps eclampsia would not exact the toll of mothers' lives which it has done in the past.

BIBLIOGRAPHY

- ¹The Management of Pre-eclampsia. Am. J. of Obs. & Gyn. June '45.
- ²Pregnancy and Diabetes. Am. J. of Obs. & Gyn. Sept. '44.
- ³Placental Infarction as a Diagnostic Criterion of Toxæmia. Am. J. of Obs. & Gyn. Nov. '44.
- ⁴Parathyroid Extract in Pre-eclamptic Toxæmia. Northwestern Medical Journal. July '44.
- ⁵Toxæmia of Late Pregnancy. J. of Iowa Medical Society. Nov. '44.
- ⁶The Treatment of Eclampsia. Irish Journal of Med. Science. Feb. '43.
- ⁷Cerebral Dysrhythmia in Relation to Eclampsia. Arch. of Neur. & Psych. Feb. '43.
- ⁸Observations in the Treatment of Eclampsia. Irish J. of Med. Sc. Nov. '42.
- ⁹Placenta in Eclampsia and Nephritic Toxæmia. J. of Obs. & Gyn. of Brit. Emp. Feb. '44.
- ¹⁰Amino acids in Toxemia of Pregnancy. Am. J. of O. & Gyn. Jan. '44.
- ¹¹A Therapeutic Regimen for Eclampsia. Am. J. of Obs. & Gyn. Jan. '44.
- ¹²Prevention of Late Toxæmia of Pregnancy in its Incipient Stages. Can. Med. Ass. J. July '45.
- ¹³The Management of Pre-eclampsia. Can. Med. Ass. J. June '45.
- ¹⁴Pre-eclamptic and Eclamptic Toxemia of Pregnancy. Dexter and Weiss.
- ¹⁵Etiology of Toxemia of Late Pregnancy. J. of Obs. & Gyn. of Brit. Emp. Oct. '44.
- ¹⁶Puerperal Convulsions as a Country Doctor Sees It. Kent. Med. J. Aug. '43.
- ¹⁷Surgical Pathology. Boyd.
- ¹⁸Serum Protein in Normal and Toxemic Pregnancy. Am. J. of Obs. & Gyn. July '45.

THE BLOOD SEDIMENTATION RATE

A. W. CARRIE 4T6

DEFINITION

If blood, to which an anti-coagulant has been added, is drawn up into a tube with a bore of 2.5 mm. and the tube is held vertically, the blood will separate into two layers, a layer of clear plasma above, and a layer of red cells in plasma below. The height of the column of clear plasma left above the settling cells at the end of one hour is known as the sedimentation rate, and is expressed in mm. per hour.

HISTORY

The history of the study of the sedimentation rate can be divided into two periods; an early period in which nothing was done to prevent clotting of the blood, and a more recent period in which the blood is prevented from clotting.

PERIOD 1.

The early Greek physicians of Hippocrates' time observed that if the blood of patients suffering from infectious diseases was allowed to stand in a container, it separated into two layers, a layer of red clot below, and a yellow fibrinous layer above. These men also found fine fibrin coagula in the hearts of people who had died of some infectious diseases, but not in those who had met an accidental death. This led them to believe that the same separation of the blood into two layers occurred in the body as occurred in the test tube. They suggested that the upper layer was injurious matter, the toxin, which was the cause of the disease. In the seventeenth, eighteenth, and nineteenth centuries, this layer became known as the buffy coat, or *crusta inflammatoria*. Blood letting was carried out to remove the buffy coat, as it was still thought that this was the cause of the disease. Hewson in 1772 first suggested that the buffy coat was just separated lymph. John Hunter noticed that the extent of this separation of the blood into two layers varied with the severity of the disease. Nosse in 1836 proved that the buffy coat owes its origin to an increased sinking velocity of red blood cells.

Thus the first period ended in 1918, having established that the buffy coat was normal lymph, whose formation was due to an increased sinking velocity of the red blood cells. It provided no accurate means to measure sedimentation, as the rapid clotting prevented observation over a long enough period.

PERIOD 2.

Fahræus in 1918 first used blood in which clotting was prevented by the addition of sodium citrate to measure the sedimentation rate; he discovered and studied the increase in the sedimentation rate in pregnancy. Westergren in 1924 suggested a simple method of measuring the sedimentation rate, requiring only a single observation at the end of one hour. Since then some 2,500 articles have been written on the sedimentation rate, suggesting causes of the elevation, new methods of measuring it, and clinical uses to which it may be put.

THE PHYSIOLOGICAL BASIS OF INCREASED SEDIMENTATION

In the majority of conditions with an increased sedimentation rate, there is an increased clumping together of the cells, an increased rouleau formation. These aggregates of cells settle much more rapidly than single cells, and thus the rate of sedimentation is increased. The other possible physical changes in the blood that could bring about increased sedimentation are—

(1) a lowered viscosity of the plasma. This is not responsible for increased sedimentation, as no appreciable change in the viscosity of the plasma could be found in conditions with an increased sedimentation rate.

(2) An increase in the specific gravity of the corpuscles. No change in the specific gravity of the cells could be found in conditions with increased sedimentation.

(3) Increase in the size of the cells. This would increase the mass of the cells more than it would increase their surface area, and thus allow faster settling. Pernicious anemia, and other macrocytic anemias, are the only disease conditions in which this factor plays a part in the rapid settling.

The question then arises—does the increased clumping of the red cells result from a change in the cells or a change in the plasma? It is due to change in the plasma. If cells of blood with a normal sedimentation rate are put in plasma of blood with an accelerated rate, the cells will fall at the fast rate, while if cells of fast blood are put in normal plasma, the rate is normal. Fahræus found that if cells are suspended in fibrinogen or globulin, their aggregation and settling is much accelerated, while if they are suspended in albumin, no aggregation occurs, and the settling is slow. Yardmudian⁴ found that in most cases of increased sedimentation rate, there were changes in the plasma proteins. He found that the greater was the plasma fibrinogen, the faster was the rate of settling; that the higher was the ratio between albumin and globulin the faster was the sedimentation; and that the sedimentation rate varied directly with the lipid content of the blood. He found that changes in basal metabolism, in blood chlorides, calcium phosphorus, non-protein nitrogen, and carbon dioxide combining power did not affect the sedimentation rate. There was a slight tendency to sluggish sedimentation when the blood sugar was over 200 mgm. per cent. Different factors are responsible for increased sedimentation rates in different pathological conditions. In pregnancy the high blood lipid produces a rapid settling. In acute infections, the rise in serum fibrinogen is responsible for the increased sedimentation rate. Here there is little change in albumin or globulin⁵. Yardmudian found that there were some cases of increased sedimentation rate that could not be explained by changes in blood protein, lipid, or by changes in cell volume.

How the proteins act to increase clumping together of the red blood cells is not known. Some believe it is due to electrical changes in the cells. The forces are not the same as those producing aggregation of colloidal particles, for Morrison¹² found that the addition of electrolytes does not hasten sedimentation of the cells. In colloidal suspensions, the addition of electrolytes will cause aggregation of the particles.

METHODS OF MEASURING THE SEDIMENTATION RATE

A good method must fulfill the following qualifications—

- (1) It must be simple, rapid to perform, and reliable.
- (2) It should cause the minimum of discomfort to the patient.
- (3) Results obtained from its use should be comparable to those obtained at other centres i.e. it should be a test that is widely used.

The methods that have been suggested can be divided into two classes—macro-metric, and micrometric. In the macrometric method, venous blood obtained by venipuncture is used, while in the micrometric method, capillary blood obtained by skin puncture is used.

MACROMETRIC METHODS

Macrometric methods are better than micrometric methods, except in children and in obese women, where venipuncture is difficult and painful. In the average individual, venipuncture causes no more discomfort than puncture of the skin of a finger. The larger tubes that can be used with larger amount of blood prevent errors from capillary forces. Of the macrometric methods, the *Westergren* method is most satisfactory.

TECHNIQUE

(1) Venous blood is obtained and mixed with anti-coagulant. In the original *Westergren* technique, .4 c.c. of 3.8% sodium citrate solution were put in a syringe. The needle connected to the syringe was introduced into a vein and blood was drawn in until the mixture reached the 2 c.c. mark. In the modified *Westergren* technique used in the Toronto General Hospital, 5 c.c. of venous blood are added to a bottle in which .2 c.c. of 5% potassium oxalate have been evaporated to dryness.

(2) This blood is drawn up in a *Westergren* tube, to the 0 mark. This tube is 2.5 mm. in diameter, and 200 mm. long.

(3) The tube is held vertically in a stand for one hour. A metal spring above the tube pushes it down on a rubber pedestal, and thus prevents the escape of blood. At the end of one hour, the height of the column of clear plasma is measured in mm. This is the sedimentation rate, and is expressed in mms. per hour.

In the Cutler, Wintrobe and Rourke-Ernstene methods frequent readings are made and charted. This is time consuming, and there is no evidence that these charted readings are of any more value than a single reading. In the Linezenmeier method, the time required for the cells to settle 18 mm. is measured. Because of the many readings required, it also is time consuming.

MICROMETRIC METHODS

Micrometric methods are much easier to use in children. Peters⁶ claims that as long as the diameter of the tube is not less than 1 mm., capillary forces will not influence the rate of sedimentation. He compared results on the same blood using a tube 1.2 mm. in diameter, and the 2.5 mm. *Westergren* tube. He

found that the greatest variation was 3 mm. settling, and that the results were frequently identical. The Landua method is the most commonly used micro-metric method.⁷ A pipette 12.5 cm. long and 1 mm. in diameter is used. It has a bulb at its upper end, and its stem has two markings, one at 12.5 mm. and the other at 62.5 mm. Sodium citrate solution is drawn up to the 12.5 mark, and then capillary blood is drawn in up to the 62.5 mm. mark. The blood and anticoagulant are thoroughly mixed in the chamber at the upper end, and then forced back into the stem below the 62.5 mm. mark. The distance the cells settle in one hour is measured. The normal is 1-6 mm. for men, and 10-15 mm. for women.

Errors in technique that will alter results—

(1) Any deviation of the Westergren tube from perpendicular while the cells are settling accelerates the rate, and thus is to be avoided.

(2) The rate should be determined within two hours of taking the blood. If the blood is allowed to stand longer the rate is decreased.

(3) All glassware used should be clean, as dirty glassware will alter the results.

(4) Extremes of temperature should be avoided, as heat accelerates the rate and cold slows it. Normal variations in room temperature can be ignored.

(5) Liquid anti-coagulants should not be used, as the dilution of the blood increases the sedimentation rate. Either powdered oxalate or citrate may be used.

VARIATIONS IN SEDIMENTATION RATE

The normal sedimentation rate, as determined by the Westergren method, is stated as 1-10 mm. per hour for men, and 3-15 mm. per hour for women. Children under 3½ years, and adults above 60 years may show a normal rate greater than this.

*Pathological conditions with an accelerated rate*³

While most cases of elevation of the sedimentation rate are due to disease processes, some are due to normal physiological changes. Menstruation and pregnancy cause an elevated sedimentation rate. In pregnancy the rate of sedimentation gradually rises from the third to the ninth week, and returns to normal four weeks post partem.

(1) INFECTIOUS DISEASES

(a) Acute—all acute infections, except appendicitis and whooping cough are characterized by an accelerated sedimentation rate.

An early rise is probably not seen in appendicitis, as the early symptoms are due to obstruction rather than infection.

- (i) Septicemia.
- (ii) Localized abscess.
- (iii) Infected sinuses.
- (iv) Acute Salpingitis.

- (v) Peritonitis.
- (vi) Acute infections of the intestines.
- (vii) Acute rheumatic fever.
- (viii) Acute nephritis.
- (b) Chronic
 - (i) Tuberculosis in active stage.
 - (ii) Rheumatoid arthritis.
 - (iii) Syphilis.
- (2) Trauma—any gross trauma will produce an increased sedimentation rate. After surgery, there is an increased sedimentation rate.
- (3) Neoplastic-conditions—Malignant tumours which have undergone necrosis often have an accelerated rate. Benign tumours rarely do.
- (4) Metabolic and toxic—
 - (a) Thyrotoxicosis.
 - (b) Myxedema.
 - (c) Diabetes mellitus.
 - (d) Arsenic, lead and alcohol poisoning.
 - (e) Pernicious anemia.
- (5) Degenerative—
Coronary thrombosis with infarction of myocardium.

Pathological conditions with a slowed rate—

- (1) Catarrhal jaundice.
- (2) Cirrhosis of the liver. In this condition there is a reversal of the albumin globulin ratio, with a decreased rate. The decreased rate is probably due to low fibrinogen, and high lipoids.
- (3) Allergic conditions—hay fever, asthma, urticaria, anaphylactic conditions.
- (4) Osteo-arthritis.
- (5) Severe cachexia.
- (6) Sickle cell anemia.
- (7) Polycythemia vera.

Conditions with normal sedimentation—

- (1) Acute appendicitis.
- (2) Whooping cough.
- (3) Functional diseases.
- (4) Heart disorders—congenital heart disease, chronic rheumatic heart disease, arteriosclerotic heart disease, hypertensive heart disease.
- (5) Most endocrine disorders.

CLINICAL VALUE OF THE SEDIMENTATION RATE

(A) *In Diagnosis*—

Elevation of the sedimentation rate is not at all specific, and is found in many different conditions. Thus it is only after a complete history and physical examination have limited the possible conditions to two or three that the sedimentation rate is of value in diagnosis.

(1) It is useful in distinguishing between organic and functional conditions. For example, in diarrhoeas of organic origin the rate is accelerated, while in functional conditions it is not.

(2) It is useful in diagnosing an arthritis with small joint involvement. The sedimentation rate is elevated in infectious and rheumatoid arthritis, while it is not in osteo-arthritis.

(3) It is of value in the diagnosis of acute abdominal conditions characterized by lower right-sided pain. In pelvic inflammatory conditions, such as salpingitis, the rate is accelerated, while in appendicitis without rupture it is not.

(4) When a bacterial endocarditis is superimposed on chronic heart disease, the sedimentation rate is elevated.

(5) It is useful in the early diagnosis of tuberculosis, as changes in sedimentation rate occur before changes in the X-ray picture appear.

(6) It may prove of value in differing benign gastric ulcer from cancer of the stomach. In ulcer it is may be normal, while in carcinoma it may be elevated.

(B) *In following the course of a disease under treatment*—

(1) In acute rheumatic fever it remains elevated as long as the disease process is active. Thus the patient should not be allowed up until his sedimentation rate has returned to normal.

(2) It is useful in following the effect of treatment on tuberculosis, and on primary atypical pneumonia.

(3) In myocardial infarction the sedimentation rate becomes raised on the fifth to eleventh days. The patient should be kept in bed until it returns to normal.

(4) It is useful in recognizing acute exacerbations of chronic nephritis.

(5) It is useful in determining the effect of penicillin on chronic osteomyelitis.

(C) *In Prognosis*—

(1) A constant increase in the sedimentation rate in the year following treatment of a malignant tumour suggests that there have been metastasis, and thus indicates that the prognosis is poor.

RELIABILITY OF THE TEST

Helm found that in only 1.6% of 94 cases, the sedimentation rate could not be co-related with the clinical picture.⁸ Cutler found that there was a discrepancy between the raised sedimentation rate and the clinical picture in only 5 of 5,000 cases. Yates and Davidson found that it was accurate in 91.4% of 6,000 cases.

SUMMARY

The increased rate of settling of red blood cells in disease has been noticed since antiquity, but it is only during the last thirty years that quantitative measurements have been carried out on blood rendered non-coagulable. Of the methods in common use, the Westergren is the most satisfactory, as it is easy to perform, does not take much time, and is widely used so that results obtained in one centre can be compared with those obtained in others. Like the majority of other laboratory tests, it is only of value when co-related with the history and physical findings. Its greatest value is the information it gives about the activity of a disease under treatment. It is also of value in distinguishing between organic and functional conditions.

I wish to thank Professor William Boyd, Professor A. Ham, and Dr. R. Mac-Millan for their helpful suggestions and criticism of this article.

REFERENCES

- ¹Fahræus—Physiological review—241-9-1929.
- ²Best and Taylor—The Physiological Basis of Medical Practice.
- ³Gradwohl—Clinical Laboratory Methods and Diagnosis.
- ⁴Yardmudian—American Journal of Clinical Pathology—7-1937.
- ⁵Frasier and Rennie—British Journal of experimental Pathology—22-p81, April 1943.
- ⁶Peters J. T.—Archives of Internal Medicine—75-1945. p. 105.
- ⁷Rogatz—Journal of Laboratory and Clinical Methods—28-L943 P. 1842.
- ⁸Helm—American Journal of the Medical Sciences—205-1943 P. 241.
- ⁹In arthritis—Treusch and Krusen —Arch. Int. Med. 72—p231—Aug. 43.
- ¹⁰In acute appendicitis—Lesser and Haufman—Surgery, Gynecology and Obstet. 73—p. 163—Aug. 41.
- ¹¹Study of Literature—Nichols—Journal of Lab. and Clinical Medicine—July, August, October, 1942—27, 28.
- ¹²Morrison—Am. J. Clin. Path.—11-July 41—P. 578.

A. W. CARRIE

Feature

C. A. F. Möës, Editor

SURVEY OF THE GRADUATING CLASS 4T6

In past years the graduating classes have recorded their views by answering questionnaires, so it was decided to carry out this procedure once again this year. One hundred answers were received from the class of one hundred and forty, and although the results are thus not representative of the whole year, nevertheless some idea of the trend of the class opinion can be seen.

The age distribution of the class is as follows :

20 years	1	25 years	4
21 "	10	26 "	3
22 "	36	27 "	3
23 "	24	28 "	1
24 "	17	30 "	1

The average age = 22.6 years.

The model age = 22 years.

Some of those in the older age group it was found either worked or took other university courses before entering medicine.

The second question asked if any members of the class had been in any occupation before entering medicine. Although the large majority enrolled on completing high school, nevertheless 30 had taken from 1-4 years university training in arts, pharmacy and forestry beforehand. Eleven more had worked for various lengths of time as pharmacists' apprentices, machinists, public school teachers, jewellers, and in endocrinology at the Connaught lab.

The next question dealt with the number of years interning or post-graduate work the class anticipated taking before going into practice.

1 year interning or post-graduate work.....	4
2 years " " "	17
3 " " " "	31
4 " " " "	25
5 " " " "	13
6 " " " "	3
7 " " " "	1
8 " " " "	1

This would tend to show that most of the students feel that even though they have graduated they still believe they should have further training before starting to practice medicine.

It is difficult for students to be sure what their choice of future practice will be, but it was found that the great majority have an idea in any case. The following selections are enlightening and will probably interest the clinicians:

General Practice	12%	Pathology	0
Surgery	22%	Radiology	1%
Paediatrics	8%	Research	0
Internal Medicine	14%	Neurology	1%
Obstetrics and Gynaecology	10%	Neurosurgery	1%
Genito-urinary Surgery	1%	Otolaryngology	1%
Orthopedics	3%	Dermatology	1%
Psychiatry	4%		

10 of those who stated they are going to specialize intend to go into general practice for a few years first; 21 were undecided about what branch of medicine they intend to practice on graduation.

As to where the class intends to practice, 15% chose a rural district; 53% a Canadian city; 24% a country outside Canada. The Canadian cities indicated were Toronto, Hamilton, Vancouver, and cities in Saskatchewan. Four said they would like to go to the U.S.A.; one to South America and one to India. Eight were undecided as to where they want to practice.

When asked the question "If you entered the University again would you choose medicine?"—87% answered yes, while 13% answered no. Amongst the courses that the latter group would have chosen were law, forestry, dentistry, physiotherapy, and physics and chemistry. It is interesting that in other years engineering was the course of preference for the majority who answered no to the question. Sixteen of those who answered the questionnaire were doctors' sons; of these there was only one who said that he might have preferred law to medicine.

Regarding the marital status of the year it was found that 68% are single; 6% are married, and 26% intend to marry in the near future.

The last question dealt with the preference for state medicine compared to medicine as it is practiced to-day. 61% stated they liked the latter, while 24% said they would prefer the former, 15% were undecided and many of these stated that they would like to see some sort of health insurance.

Abstracts

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MEDICINE I

SOME OBSERVATIONS ON THE USE OF THIOBARBITAL AS AN ANTITHYROID AGENT IN THE TREATMENT OF GRAVES DISEASE. E. B. Astwood: *J. of Clinical Endocrinology*. 1945, 5:8.

THE results of this author's work shows that thiobarbital is a little more than twice as effective as thiouracil. A single oral dose has a more prolonged action than a single dose of thiouracil, being quite effective when only one dose is given per day, but it is more effective when given every twelve hours.

In this series there was a very high incidence of side effects, but from the small number of cases reported on (30) a true analysis of the toxic effects was not possible. The high rate of fever was probably due to the cumulative effect of the drug, but unlike thiouracil this fever appeared to be entirely benign and the drug could usually be continued. One case of fatal liver disease and one fatal case of agranulocytosis were reported.

The dosage recommended was 50 mgms. every twelve hours. It was suggested that it would be unwise to give a larger dose than 0.2 gms. daily.

R. W. L-H.

MEDICINE II

TREATMENT OF ESSENTIAL HYPERTENSION WITH SODIUM THIOCYANATE. Beamish and Adamson: *C.M.A.J.* 53. Sept., 1945.

THE use of thiocyanate salts in the treatment of hypertension has been known for many years but the frequent occurrence of toxic effects prevented the general use of these drugs. In 1936 M. H. Barker demonstrated by blood cyanate, and blood clearance tests, that maintenance of a suitable blood level was necessary for effective symptomatic relief and avoidance of toxicity.

The authors selected ten patients for testing the drugs. During a control period averaging 3 to 4 weeks, the blood pressure was obtained under basic conditions for each patient. Then sodium thiocyanate therapy was begun, the patient being on and off sodium thiocyanate for alternate periods of eight weeks during which time the blood pressure was recorded under basic conditions. Psychic effect of the therapy was avoided by removing the drug unknown to the patients during the alternate periods. Six of the patients showed good response with marked fall in blood pressure while one showed major toxic effects.

The authors conclude that with an optimum blood level of 8 to 12 mgms. per 100 cc. and with selected patients showing maximum symptoms and minimum cardiac and renal damage, good results can be obtained.

N. K.

SURGERY I

MARCH FRACTURES. Walter Scott, M.D., F.A.C.S.: *Surgery, Gynecology, and Obstetrics*, Vol. 81. Nov., 1945, page 525.

THE term March fracture was originally used to describe fractures, most often incomplete, of the metatarsal bones, occurring after repeated minor trauma. They were so named, as 46% were found to occur after marches. These fractures are rare in peace, but common in war. They are chiefly seen in the recruit who is undergoing basic training. Similar fractures, only going part way through the cortex, have been found in the tibia, femur, fibula, os calcis, pelvic bones, and ribs. J. B. Hartley has classified all these together under the term fatigue fractures of bone.

The author reports on 58 cases which he saw at a large Naval training centre. He found that only the second and third metatarsals were involved, never the first, fourth or fifth. 90% of these fractures were incomplete, i.e. the fracture extended only part way through the cortex. He found that the average B.M.R. of these individuals was—10.72, and the average pulse rate was 62 per minute. On the basis of this, in spite of the fact that normal variations of plus or minus 15 are permissible in the basal metabolic rate, and in spite of absence of control figures on others who did not have fractures, he puts forth the hypothesis that mild hypothyroid state predisposes to March fractures.

Clinical course

The usual history is that a 18 year old trainee, after one to twelve weeks of basic training notices a burning sensation in his foot after a hike of five miles or more. He develops a limp, and a soft tissue swelling appears over the dorsum of his foot. These symptoms increase in severity during the first week, remain stationary for one week, and then gradually subside over two or three weeks.

Treatment

Good results are obtained by placing the leg in a short leg plaster for three to five weeks. In the two or three weeks after the cast is removed the patient is given physiotherapy, with a gradual return to weight bearing. The patient can be up and around in his cast as soon as the soft tissue swelling subsides. This can be differentiated by palpation in the tissues picked up it is soft tissue swelling; if not, it is callus. In the belief that a mild hypothyroid state predisposes to this condition, he gave his patients 1 gr. of desiccated thyroid t.i.d. He found this had no effect on the end result, but that 63% thus treated were symptom free, while only 43% of those who did not receive thyroid were symptom free after the fracture had healed. The symptoms complained of were local pain and stiffness for a few days.

A. C.

SURGERY II

REFRIGERATION ANESTHESIA. H. O. Horner: *Am. J. Surg.* Nov., 1945.

THE lowering of temperature just above freezing produces anesthesia by stopping cellular metabolic processes. Cells at this temperature do not respond to stimuli and thus pain and shock are avoided. With a tourniquet and ice-pack the temperature falls to 2 to 4 degrees centigrade and surgical anesthesia is produced.

Its advantages include: lowering of metabolism with less oxygen demand; anesthesia of the protoplasm; arresting irritability; relieving of pain as produced by sudden arterial occlusion; reducing shock since there is little pulse and blood pressure change; inhibiting infection and edema; healing by first intention but slower than other forms of anaesthesia.

Its indications are: peripheral vascular disease with circulatory insufficiency; uncontrollable limb sepsis; severe trauma with circulatory impairment.

When spreading sepsis is present in the arteriosclerotic limb, continuous refrigeration may be used for several days while the general condition is improving.

The method is then described. It consists of placing a thin rubber tourniquet around the extremity to cut off the blood supply and ice is then packed around the leg. Temperature is kept around 5 degrees centigrade. The time required ranged from 1 to 8 hours. When the wound is ready for closure the tourniquet is removed and bleeders tied off.

This anesthesia is not intended to supersede other forms of anesthesia when the general condition of the patient is good.

G. W.

OBSTETRICS AND GYNECOLOGY I

THE TREATMENT OF PRIMARY DYSMENORRHEA WITH DE-PROTEINATED PANCREATIC EXTRACT (DEPROPANEX). L. E. Grossman: *Am. J. Obs. and Gyn.* 50:8, 1945.

A BRIEF review of the more common theories of the etiology of essential dysmenorrhea is presented, the presence of active uterine contractions being especially noted. Depropanex which has been used in the fields of peripheral vascular disease and urology, is nontoxic and effects a relaxation of spastic smooth muscle. It is a saline solution of a chemically derived protein-free nitrogenous fraction obtained from the acid-alcohol treatment of beef pancreas, free from insulin, histamine or acetylcholine and with a pH of 6.5 to 6.8. Dosage used was from 1.4 to 4.0 cc. intramuscularly.

Uniformly consistent and favourable results were observed in a group of patients in private practice with moderately severe to severe dysmenorrhea. Complete relief was afforded within 15 to 60 minutes subsequent to administration in 79.4% of cases and partial relief was obtained in this time in 17.5% of cases.

Results in an industrial group were not as favourable probably due to factors not encountered in private practice.

R. W. L-H.

OBSTETRICS AND GYNECOLOGY II

CAUSES OF VAGINAL BLEEDING IN WOMEN OVER THE AGE OF FORTY. R. W. Noyes: *Western Journal of Surgery, Obstetrics and Gynecology*, 45: 10

415 women over forty with vaginal bleeding as a symptom were studied. Forty-five per cent of these were postmenopausal. The incidence of carcinoma of the cervix was found to be 6.2% in the premenopausal group and 16.6% in the postmenopausal group.

Carcinoma of the cervix was twice as frequent as carcinoma of the fundus. The cases of ovarian and vaginal carcinoma were too rare for comparison. In several cases of carcinoma of the vulva encountered, bleeding was not a symptom.

Both benign lesions and carcinoma caused the onset of bleeding on the average of eleven years after the menopause. The bleeding from the benign lesions of the cervix and vagina began nearly twice as long after the menopause on the average (14.7 years) as benign lesions of the uterus (7.2 years). The incidence of bleeding due to senile vaginitis was somewhat higher in younger menopausal women, probably because of frequent trauma, than in older groups where one would expect more marked senile changes.

Myomas alone and in combination with other benign pelvic pathology caused 1/3 of all cases of bleeding in the premenopausal group. Bleeding from endometrial polyps had its highest incidence in premenopausal women of the fifth decade.

Seven per cent of postmenopausal and three per cent of menopausal bleeding was attributed to estrogen withdrawal. The author substantiated the contention that the indiscriminate use of hormones is dangerously obscuring diagnosis at present.

In 15% of premenopausal women, no cause could be found for the bleeding. The cause of bleeding could not be determined by history or physical examination alone in the idiopathic group, cases due to estrogen withdrawal, chronic cervicitis, carcinoma of the fundus or carcinoma of the ovary—cases amounting to a total of 45% in the postmenopausal and 53% in the premenopausal group. The author believes that surgical and pathological studies must be freely used in order to make a diagnosis in such cases.

R. W. L-H.

OTO-LARYNGOLOGY I

CHRONIC SINUSITIS. O. E. Van Alyea, M.D.: *Annals of Otology, Rhinology, and Laryngology*, Vol. 54. Sept., 1945, page 443.

Nature has provided capable and well organized defences against infection of the sinuses, and any treatment must aid them, not replace them. These defences consist of:

- (1) Thick tenacious mucous, which covers the mucous membranes, protecting them from bacteria;
- (2) Cilia which move this mucous toward the exterior.

A constant flow of mucous is usually significant of a healthy nose.

Nasal sprays which interfere with the action of the cilia should not be used. The sulphonamides are alkaline and irritating. Ephedrine in saline does not interfere with the cilia and can be used.

All methods fail which do not aid in the improvement of sinus drainage. This should be done as simply as possible—by irrigations, by the removal of polypi, or if necessary by septal resection. There is no reason to remove the turbinates; they serve the useful function of warming the air. There is no reason to remove the lining of the sinus. Pathological studies of the tissue removed at operation at the University of Illinois showed no degenerative change, no signs of abscess formation, and no ulceration. The membrane is thickened, and infiltrated with inflammatory cells, providing an active barrier against infection. In simple chronic sinusitis lymphocyte and plasma cells are found, in chronic suppurative sinusitis, polymorphs. Many eosinophiles are found suggesting that allergy plays a large part in chronic sinusitis. Allergic edema obstructs the opening of the sinus, and thus predisposes to infection.

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